expansion chamber **3** between apertures **2** and **5**, It is then possible to vent the expansion chamber **3** and region **14** to atmospheric pressure whilst maintaining high vacuum in region **15**. This facilitates access to the components most prone to contamination, so that they can be readily replaced or refurbished.

The ions that have passed through aperture **11** are directed by an ion lens **16** into an ion optical device **17**. Device **17** assists in containing the ion beam, which otherwise would tend to diverge rapidly under the influence of positive ion space-charge, and cause severe loss of sensitivity. The directed flow of neutral gas from the plasma, however, is not confined by the ion optical device **17** and diverges from the ion beam to be removed, along with the general back pressure of gas in the chamber **6**, by the vacuum pump **7**. Device **17** may be a quadrupole, a higher order multipole, an ion guide or an ion lens. As mentioned above, it is advantageous if the transmission-enhancing device can be made to be mass-selective. Preferably it will be a quadrupole, although in principle another mass selective device, such as a magnetic sector, could also be employed.

Ions transmitted by device **17** are focussed by the ion lens **18**, and pass through an aperture **19** into the second evacuated chamber **20**, maintained at a pressure lower than that of the first evacuated chamber **6** by a high-vacuum pump, preferably a turbo-molecular pump, located at **21**. The pressure of this chamber is of the order 10^{-3} to 10^{-5} mbar, typically $1–2\times10^{-4}$ mbar. Aperture **19** has a relatively small diameter, typically 2–3 mm, thus establishing a pressure differential between the first evacuated chamber **6** and the second evacuated chamber **20**. This prevents the background gas from chamber **6** from entering chamber **20**, reducing the gas load on chamber **20**, and so minimises any residual pressure in the chamber **20** due to the neutral gas load from the plasma. It is advantageous if aperture **19** is mounted on an insulator **22**, so that it can be biased negative, causing ions to pass through it with relatively high translational energy. This helps to ensure efficient transport of the ions through the aperture **19** both by lowering the charge density within the beam and by minimising the beam divergence.

The ions are focussed by ion lens **23** into a collision cell **24**, which is located in the second evacuated chamber **20**. The collision cell **24** has an entrance aperture **27** and an exit aperture **28**. As the ion beam emerges from the aperture **19**, the neutral gas flow diverges and is skimmed off by the entrance aperture **27** of the collision cell **24**, thus further reducing the gas load on the collision cell **24**. Located in collision cell **24** is a multipole ion optical assembly **25**. This may be a quadrupole, hexapole or octapole. The collision cell **25** is pressurised with a target gas **26**, chosen for its capacity to remove, via a mechanism such as attachment or fragmentation, unwanted molecular ions from the ion beam whilst influencing other ions minimally. Typically the target gas may be helium or hydrogen, although many other gases may prove beneficial for specific analytical requirements.

Apertures **27** and **28** limit the gas conductance out of the collision cell, thus allowing it to operate at a relatively high pressure, typically in the range 0.001 mbar to 0.1 mbar, whilst minimising the gas load on chamber **20** and its associated high vacuum pump **21**. The transport efficiency of ions through apertures **27** and **28** is improved by biassing the apertures negative. They are mounted on the collision cell by means of insulating gas-tight supports **29** and **30**.

Ions that leave the collision cell **24** are accelerated and focussed by ion lens **31** through an aperture **32**. This aperture establishes a pressure differential between chamber **20** and the third evacuated chamber **33** thus reducing the gas load on chamber **33**, and further minimising any residual pressure therein due to the neutral gas load from the plasma. It is advantageous to mount aperture **32** on an insulating support **34**. The aperture **32** can be then biassed negative with respect to ground, typically to −100 volts, so that ions pass through it with relatively high translational energy. This helps to ensure efficient transport of the ions through aperture **32** both by lowering the charge density within the beam and by minimising the beam divergence.

The ions pass through aperture **32** at relatively high translational energy, and pass through a double deflector **35** preferably at the same or higher energy. This deflects the ion beam away from the original instrument axis **9** and along the axis **36** of the quadrupole mass filter **37**, which is used to mass analyse the ion beam. The double deflector **35** is advantageously in the form of two small cylindrical electrostatic sectors, cross-coupled and in series. We have found this configuration to be especially effective in reducing to below 1 CPS the unresolved baseline noise signal that is generally present in ICPMS instruments.

Ions of the selected m/e or range m/e are transmitted to a detector, which is typically an electron multiplier **38**. The first dynode of the electron multiplier **38** is offset from axis **36** of the quadrupole mass filter, which further helps to minimise the unresolved baseline noise signal. Both the mass filter **37** and the detector **38** are housed in the third evacuated chamber **33**, which is maintained at a pressure lower than that of the second evacuated chamber **20** by a high-vacuum pump **39**. The pressure of this chamber is less than 10^{-4} mbar, typically about 10^{-6} mbar, although certain types of ion detectors can operate at pressures as high as $2–5\times10^{-5}$ mbar.

The invention claimed is:

1. A mass spectrometer, comprising:

an ion source for generating an ion beam from a sample introduced into a plasma, the beam containing unwanted gas components and artifact ions;

a collision cell within an evacuation chamber, the collision cell being disposed to receive at least a portion of the ion beam from the ion source and arranged to be pressurized with a target gas for removing unwanted artifact ions from the ion beam in the collision cell;

an ion optical device configured upstream of the collision cell to reduce gas loading from the ion source on the collision cell; and

a mass-to-charge ratio analyzer disposed within an analyzing chamber and arranged to receive at least a portion of the ion beam from the collision cell and to mass analyze the received ion beam to produce a mass spectrum of the received ion beam.

2. The mass spectrometer of claim **1**, further comprising an ion transmission-enhancing device, the ion transmission-enhancing device comprising the ion optical device.

3. The mass spectrometer of claim **1**, wherein the ion optical device comprises a quadrupole, multipole, ion guide, ion lens or sector.

4. The mass spectrometer of claim **3**, wherein the ion optical device comprises a magnetic sector.

5. The mass spectrometer of claim **1**, wherein the ion optical device is mass-selective.

6. The mass spectrometer of claim **1**, further comprising a sampling aperture configured to transmit some of the ions from the ion source into an evacuation expansion chamber upstream of the ion optical device.

7. The mass spectrometer of claim **6**, further comprising an aperture to transmit some of the ion beam from the expansion chamber into the evacuation chamber.